UTAH GEOLOGICAL SURVEY

# SURVEY NOTES

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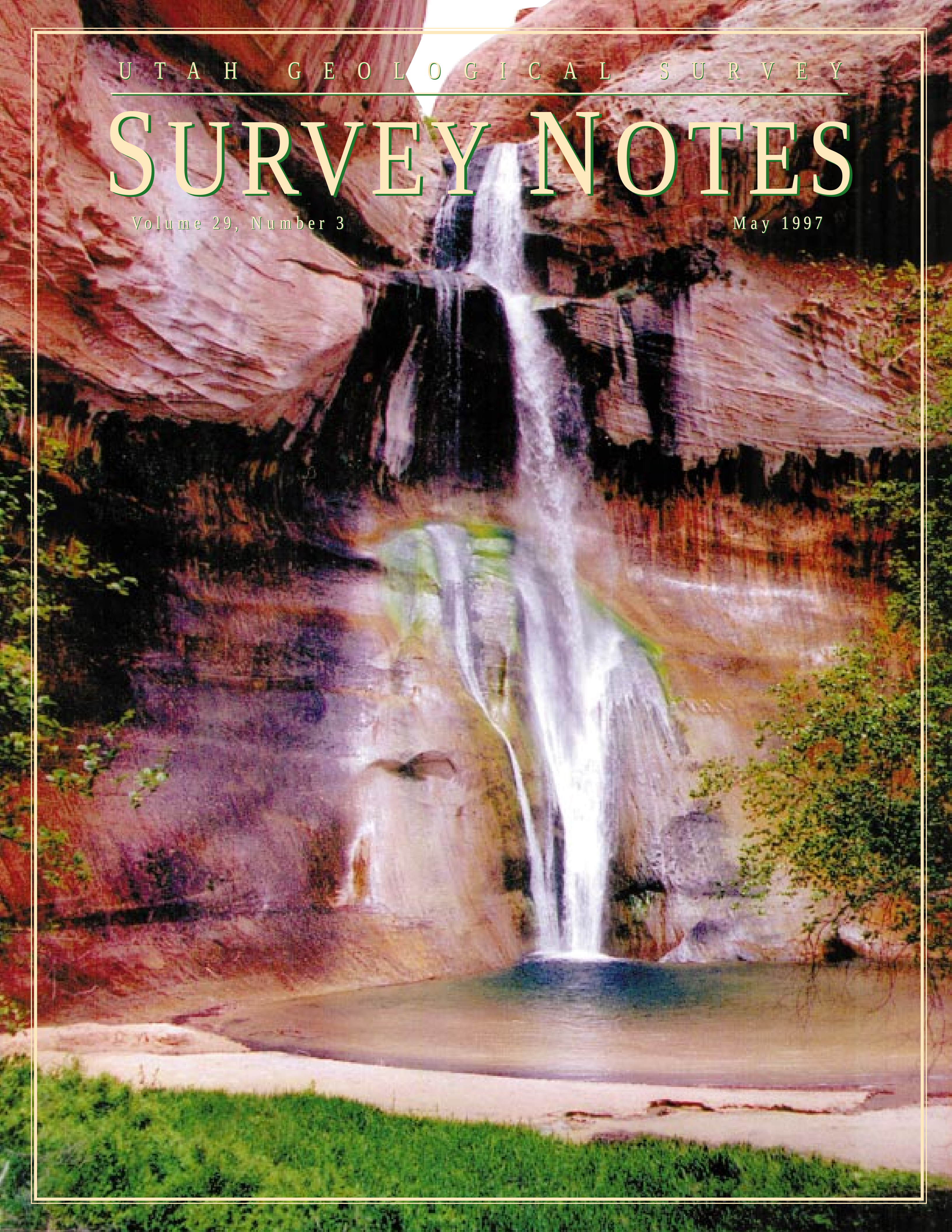

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***Design by Vicky Clarke***

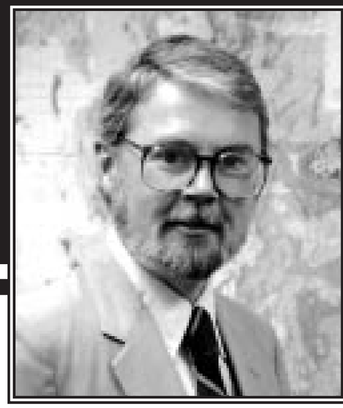
***Cover photo: Lower Calf Creek Falls in the Grand Staircase-Escalante National Monument by Werner Haidenthaller***




**ISSN 1061-7930**


# The Director's Perspective

**by M. Lee Allison**



### "If you print it, they will read it."

For many scientists, that phrase epitomises the philosophy of how to get technical information out to the people who want or need it, to ensure that information is used to make rational decisions. Unfortunately, in today's world this approach to customer service is not sufficient, and in fact, probably never was.

Too often we scientists print the results of our investigations and expect that the people most affected by or interested in it will search us out, find the information they need, correctly understand and interpret it, and then properly implement that information. Some people also believe in the Easter Bunny.

For the UGS to carry out our mission (to make Utah richer through resource development and safer from geologic hazards) we have to ensure that our results are not just technically accurate. We need to get the information into the hands of potential users, and in many cases, guide them in using it. When we are dealing with technical data users, such as geologists working in oil and gas, mining, or geotechnical areas, we at least speak the same language. Our emphasis is on making them aware that the information exists and is available. For the non-scientist, there are other hurdles. Much of the general public and many decisions-makers do not know we exist. Those who are aware of us, commonly do not think to seek us out when our information or assistance could be helpful. Therefore, it falls on us to be more assertive in letting the public, industry, and government know what products and services we offer and what information they can use.

To achieve this, we are emphasizing getting our information disseminated to potential users, and working with them to see that it is most effectively implemented. Each geologist is responsible for targeting the people, agencies, or companies that could make use of new data or reports we prepare. Our Editorial Section continues to enhance the production quality and characteristics of our publications, making them more understandable and attractive. The Geologic Extension Service is given a major role in our effort. In addition to responding to inquiries, running the UGS website, and preparing public-information materials, they have recently hired Tim Madden as our first full-time public affairs officer. Tim works with UGS geologists to ensure their work products are getting to the customers who need them most, in a form that is best used. Tim is also charged with media relations, marketing and promotion of publications, and coordinating workshops, conferences, seminars and conferences for the UGS.

For the UGS, carrying out research is not an end to itself. The purpose of our research is to put results into practice to benefit the people of Utah.

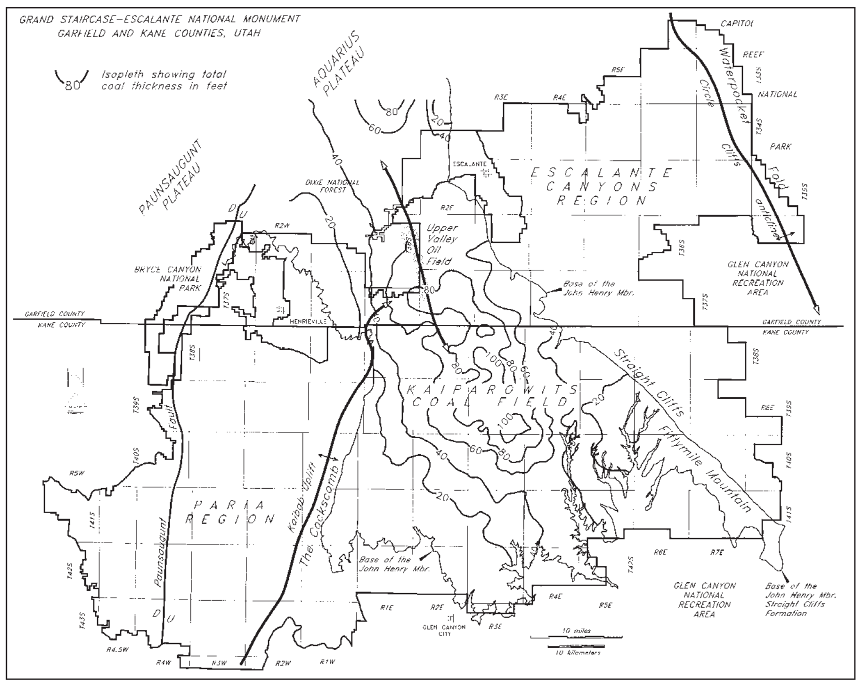

*Survey Notes* is published three times yearly by Utah Geological Survey, 1594 W. North Temple, Suite 3110, Salt Lake City, Utah 84116; (801) 537-3300. The UGS inventories the geologic resources of the state, identifies its geologic hazards, disseminates information concerning Utah's geology, and advises policymakers on geologic issues. The UGS is a division of the Department of Natural Resources. Single copies of *Survey Notes* are distributed free of charge to residents within the United States and Canada. Reproduction is encouraged with recognition of source.

# Energy and Mineral Resources within the Grand Staircase - Escalante National Monument

*by UGS Staff*

Recently, the Utah Geological Survey (UGS) released a report summarizing the present knowledge of mineral and energy resources of the newly created Grand Staircase-Escalante National Monument. This article is excerpted from that report, which was released as UGS Circular 93. Since the designation of the Grand Staircase-Escalante National Monument by President Clinton on September 18, 1996, unresolved issues regarding the mineral value of state and federal lands within the monument have come to the forefront of debates. The monument encompasses 1.7 million acres in Kane and Garfield Counties, Utah (figure 1) and includes some of the most energy-rich lands in the lower 48 states. The U.S. Bureau of Land Management (BLM), the agency assigned to manage the monument, recently has begun a three-year program to formulate a management plan. Part of the management plan will likely focus on the disposition of more than 176,000 acres of Utah School Trust lands that are now monument in-holdings. The School and Institutional Trust Lands Administration (SITLA) controls mineral rights on more than 200,000 acres of the monument.

During President Clinton's proclamation speech, he addressed the issue of lands within the monument belonging to the school children of Utah. He stated in effect that Utah's school children would not be denied the value held within these lands. Moreover,




*Grand Staircase-Escalante National Monument showing Kaiparowits coal field, Upper Valley oil field, physiographic features, and major geologic structures.*

he directed the Interior Secretary to quickly move to trade the Utah School Trust lands within the monument for other federal lands or resources in Utah that are of comparable value. With the creation of the monument, mineral lands may have been effectively removed from consideration for mining, oil and gas exploration, and other resource production (table 1).

The main mineral-resource issue is the inclusion of the Kaiparowits Plateau coal field within the monument boundary. The coal field is the largest in Utah, containing over 62 billion tons of coal in place (Hettinger and others, 1996). Using a resource assessment recently completed by the U.S. Geological Survey (USGS) (Hettinger and others, 1996) and excluding resources considered unminable, the UGS estimates that, at a minimum, 11.36 billion tons of the coal resource are technologically recoverable from the entire field. Of this total, the UGS further estimated that some 870 million tons of this coal are technologically recoverable from Utah School Trust lands within the monument.

The Utah Office of Energy and Resource Planning (OERP) performed a preliminary valuation of coal lands in the monument and projected royalty and bonus bid revenues to the State of Utah and the Federal Government. From this analysis, OERP determined that potential revenue to the state from recoverable coal could be $9.25 billion in present dollars over the life of mining. The U.S. Government would receive an equal amount. Revenue to the Utah School Trust could be an additional $1.54 billion. OERP also estimated that $65.15 million in present dollars could have been realized as income by the state just from the proposed Smoky Hollow mine project of Andalex Resources over the proposed 30-year mine life. Of this total, OERP estimated that the Smoky Hollow project would have generated some $17.97 million in income to the State School Trust.

Most of the Kaiparowits Plateau coal field also has potential for development of coal-bed methane gas, even though no definitive studies have been done to date. Based on research in other Utah coal fields and extrapolating to the Kaiparowits field, the UGS estimates that the coal beds of the Straight Cliffs Formation contain between 2.6 and 10.5 trillion cubic feet of methane.

The monument contains all the elements necessary for major oil and gas accumulations: source rocks, reservoirs, and trapping mechanisms. Commercial deposits of oil have been discovered both within and along the margins of the monument at Upper Valley field. Although the characteristics of the monument and Kaiparowits basin as a whole are favorable for the accumulation of oil and gas, wildcat-exploration-well density is extremely sparse. Only 47 exploratory wells have been drilled within the monument, or an average of 57 square miles per well. The postulated reasons for this apparent lack of exploratory activity are: (1) inaccessibility, (2) lack of oil and gas pipelines, (3) low success rates, (4) the collapse of world oil prices in 1986 and a nationwide oversupply of natural gas, and (5) environmental concerns and restrictions. Although the exploration risk is high, the monument could contain major accumulations of oil based on the production history of Upper Valley field and geologic evidence.

Solid hydrocarbons impregnate Triassic-age sandstone and siltstone along the flanks of the breached, Circle Cliffs anticline in the northeastern part of the monument. Known as tar sand, such deposits are essentially exhumed, fossil oil reservoirs where the lighter, more volatile fractions have been removed due to exposure. The entire west flank of the Circle Cliffs tar-sand deposit and a small part of the east flank are located in the monument. The remainder is within Capitol Reef National Park. Although there has been little recent commercial interest in extracting oil from the tar-sand deposits of the Circle Cliffs, researchers have estimated that as many as 550 million barrels of oil might be contained within tar sands of the monument.

Metallic mineral occurrences in the monument include gold, copper, manganese, titanium, zirconium, uranium, and vanadium. Most occurrences are small, low-grade, and have little development potential. Minerals such as titanium, zirconium, and vanadium, however, are considered “strategic and critical” and may have development potential within the monument. Uranium with associated copper plus trace amounts of cobalt occurs in the Shinarump Member of the Triassic Chinle Formation in the Circle Cliffs area of the northeastern section of the monument. About 75,000 pounds of $U_30_8$ was reportedly produced from these deposits during the 1950s and 1960s. Vanadium associated with the uranium was produced as a by-product. Anomalously radioactive outcrops of the Jurassic Morrison Formation have been noted on the east side of Fiftymile Mountain, suggesting the possibility that uranium minerals extend beneath the Kaiparowits Plateau.

Fossil, placer titanium-zirconium deposits occur in the Cretaceous Straight Cliffs Formation in a 40- to 50-mile-long belt along the east side of the Kaiparowits Plateau. The deposits were never developed commercially because they are remote and because of problems associated with mining and beneficiation. However, the deposits are reportedly rich in rutile (titanium) and zircon (zirconium).

Records obtained from the Utah Division of Oil, Gas and Mining indicate that five small mining operations are currently under permit in the monument. About 300 tons of alabaster, a fine-grained form of gypsum used for ornamental carvings, is quarried annually in four of these operations. The fifth is a suspended operation that mined petrified wood.

Additional information on the Grand Staircase-Escalante National Monument is contained in UGS Circular 93, which can be purchased for $4.00 at the Natural Resources Bookstore at 1594 West North Temple, Salt Lake City, Utah 84116 [(801)537-3320]. Information is also available on the UGS home page at *http://www.ugs.state.ut.us*.

**References**

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Doelling, H.H.,1975, Geology and mineral resources of Garfield County, Utah: Utah Geological and Mineral Survey Bulletin 107, 175 p.

Doelling, H.H., and Davis, F.D., 1989, The geology of Kane County, Utah: Utah Geological and Mineral Survey Bulletin 124, 192 p. , 10 pls.

Hettinger, R.D., Roberts, L.N.R., Biewick, L.R.H., and Kirschbaum, M.A., 1996, Preliminary investigations of the distribution and resources of coal in the Kaiparowits Plateau, southern Utah: U.S. Geological Survey Open-File Report 96-539, 72 p., 1 pl.

*Table 1. In-place mineral and energy resources within Grand Staircase-Escalante National Monument by county (after Allison, 1997).*

| Resource | Total within Monument | Portion within Garfield County | Portion within Kane County | Nature of Estimate | Comments (Source) |
|---|---|---|---|---|---|
| Coal | 62.310 billion tons | 27.713 billion tons | 34.597 billion tons | Identified and Geologic | All coal beds greater than 1 foot. (Hettinger and others, 1996). |
| *Coal* | 47.209 billion tons | 17.012 billion tons | 30.197 billion tons | *Identified* | *As above* |
| *Coal* | 15.101 billion tons | 10.701 billion tons | 4.400 billion tons | *Geologic* | *As above* |
| Coal-bed Methane | 2.63 to 10.51 TCF (trillion cubic feet) | .66 to 2.63 TCF (trillion cubic feet) | 1.97 to 7.89 TCF (trillion cubic feet) | Geologic | Calculated using average gas content of 100 cu. ft./ton and 400 cu. ft./ton. (Allison, 1997) |
| Oil | 200,000 to 400,000 bbls | 200,000 to 400,000 bbls | none | Geologic | Remaining reserves in Monument portion of Upper Valley field. Based on current production assuming 3 to 6 year life. |
| Oil | 270 million bbls | 81 million bbls | 189 million bbls | Hypothetical | Total based on percentage of oil-generating capacity of Chuar Group. County division based on county percentage of untested traps. (Allison, 1997) |
| Carbon Dioxide | 1.0 - 4.0 TCF (trillion cubic feet) | 1.0 - 4.0 TCF (trillion cubic feet) | Unknown, not tested | Geologic | (Allison, 1997) |
| Tar Sands | 550 million bbls | 550 million bbls | None | Geologic | (Allison, 1997) |
| Titanium Zirconium | 1 to 3 million tons ore @ 4 to 14% zircon, 18 to 45% ilmenite-equivalent | 80,000 to 300,000 tons ore | 920,000 to 2,700,000 tons ore | Geologic | (Allison, 1997) |
| Uranium | 30,000 to 50,000 pounds $U_3O_8$ | 30,000 to 50,000 pounds $U_3O_8$ | none | Geologic | Circle Cliffs area only. Assumes discovery of 2 to 3 deposits downdip from similar deposits. Probably low grade: 0.10 to 0.20 percent $U_3O_8$ . |
| Manganese | 20,000 tons at 35% Mn | none | 20,000 tons at 35% Mn | Geologic | (Allison, 1997) |
| Copper | 9,000 tons at 5% Cu | 6,000 tons at 3.5% Cu | 3,000 tons at 8.0% Cu | Geologic | Erratic and discontinuous mineralization - probably sub-economic. Estimate from descriptions of known occurrences in Doelling (1975) and Doelling and Davis (1989). |
| Industrial Rocks and Minerals | Unknown | | | | Present within the monument but no work done to date to evaluate size and nature of resources. |

| | |
|---|---|
| Identified: | Based on surface exposures and sufficiently close drilling - Reasonably assured resource with moderately well-established size. |
| Geologic: | Based on reasonable projection of surface exposures and samples but with little, if any, drill confirmation or assumption of discovery of deposits similar to those known in area - Reasonably assured resource but size and grade not well defined. |
| Hypothetical: | Based on geologic models and genetic concepts with little independent confirmation - Resource may or may not be present. |

# Central Utah - *A Global Geologic Field Laboratory*

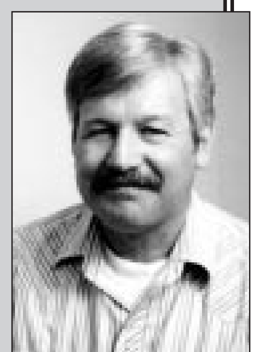
*by Douglas A. Sprinkel*

Twenty years ago I looked through an atlas of paleogeographic maps of the Rocky Mountain region. These maps colorfully documented the contemporary knowledge of what was known about the distribution and thickness of the rock units from each geologic period. I was struck by the large volume of information assembled for each period, and the fact that I could flip through the pages to visualize the changes in depositional environments through time. I imagined that if I could flip the pages fast enough I could see ancient seas flooding large expanses of land and then retreating. I could see ancient river systems flowing from newly created highlands. I could see expansive dune fields migrating across the countryside. But what impressed me the most was the large uncolored area positioned in central Utah on some of the maps. This uncolored area contained only question marks and the word "unknown." It reminded me of some 15th century mariner's map. The only difference was the atlas did not show sea monsters and giant squids lurking in the unknown area.

Today, more is known about the geology of central Utah thanks to research and geologic mapping conducted by university professors and their students, the U.S. Geological Survey, and the Utah Geological Survey; to the activity of members of the Utah Geological Association and other professional geological organizations; and to research and exploration by companies and consulting geologists who made their data and knowledge available to the public. An area that was once uncolored on paleogeographic maps is now developing into a global geologic field laboratory.

What do I mean by a global geologic field laboratory? It is a place where the rock units are well exposed and accessible and subsurface information is available, and thus can be used as an analogy to geologically similar places in the world where outcrops and subsurface data are scarce or nonexistent. It is a place where geologic models are developed and tested and where geologists can come to study examples of geologic paradigms or change those paradigms.

Utah, and particularly central Utah, can be considered a global geologic field laboratory. It contains world-class examples of: (1) normal and thrust faulting, (2) syntectonic deposition and deformation along a foreland basin, (3) modern and ancient lacustrine strata deposited in basins formed by extension and contraction, and (4) wave- and river-dominated deltaic systems. For example, multinational petroleum companies have, for many years, studied and used the Upper Cretaceous section in central



*Doug Sprinkel received his BS (1975) and MS (1977) in geology from Utah State University. Doug was employed by Placid Oil Company from 1976 to 1986 where he directed a frontier exploration program that encompassed the western United States. His work at Placid also included geologic projects that evaluated the petroleum resources of parts of Alaska, Canada, Mexico, and Turkey. Doug has been employed by the Utah Geological Survey since 1986, serving as Senior Geologist of the Applied Geology Program, as Deputy Director, and as manager for the UGS Computer Resource group. Doug is currently Staff Geologist and is conducting stratigraphic, structural, and petroleum studies in Utah's thrust belt and Basin and Range Province.*

Utah as an exploration model for wave- and river-dominated deltaic systems in this and other countries. Now that these companies have made petroleum discoveries around the world in these deltaic systems, they are returning to central Utah to study the same section in detail to better understand its oil reservoir characteristics to improve on reservoir management practices. In addition, the Upper Cretaceous was one of the classic sections studied during the development of the geologic discipline of sequence stratigraphy, and is still used to instruct geologists in sequence-stratigraphic concepts.

Central Utah is also an excellent area in which to view the dynamics between syntectonic deposition and deformation associated with a developing foreland basin. Advancing thrust wedges supplied the sediments for an extensive piedmont along the western margin of the Cretaceous foreland basin, and growth structures preserved in the syntectonic strata illustrate the style and timing of deformation as thrust faults propagated eastward into their own erosional debris. Outcrops from the Canyon and San Pitch Mountains display more than 1,100 meters of Lower Cretaceous and up to 2,000 meters of Upper Cretaceous syntectonic fluvial strata as well as growth structures such as progressive unconformities and fault-propagation folds. These examples rival the world-class exposures found in Spain's Pyrenees Mountains.

Although the uncolored area on the maps of central Utah has shrunk, it has not disappeared. Fortunately, work continues in central Utah on a variety of academic, government, and industry projects. These projects include stratigraphic and structural studies of the Canyon Mountains and eastern Sevier Desert, geologic mapping in the San Pitch Mountains, petroleum system evaluation in central and south-central Utah, and petroleum exploration by independent and major oil companies. We have a good understanding of the geology of central Utah, but we must continue to work on existing projects and encourage new projects. Not only will the results of existing and future projects enhance our knowledge of central Utah but, more importantly, these projects may lead to significant intellectual and economic discoveries of international significance.

*The Canyon Range thrust; east-dipping Cretaceous-age rocks thrusted over by west-dipping Precambrian-age quartzites. View is to the north. (photo: T.F. Lawton)*

In the next year, the Geological Society of America (GSA) and the American Association of Petroleum Geologists (AAPG) will hold their annual meetings in Salt Lake City. During those meetings, about one-fifth of the GSA and AAPG field trips will traverse central Utah and discuss various aspects of its spectacular geology including tectonics, sequence stratigraphy, reservoir characterization studies, and paleontology. The meetings and field trips during the next two years will provide some of the best opportunities to discover why central Utah is a global geologic field laboratory.

# Teacher's Corner

To keep up to date on UGS resources and workshops for teachers, visit our Teacher's Page on the UGS Web Site. The address is: http://www.ugs.state.ut.us/tcorner.htm

Listed on the Teacher's Page are: (1) general educational materials, (2) teaching kits available for loan, (3) upcoming field trips, (4) teacher inservices and workshops, (5) curricula materials, and (6) Teacher's Corner articles from Survey Notes.

A unique workshop planned for June 16-27 is **Earth Systems Science: Content & Inquiry for 9th-grade teachers**. During this workshop, you will spend two weeks probing the Great Salt Lake and its surrounding environments, plus exploring Yellowstone National Park. The focus will be on the geological, hydrological, and internal energy systems that formed these regions. Four hours of graduate credit (contact Sandy Eldredge at 537-3325 for more information).

# Tintic May Mine Again

## *Positive Exploration Results at Burgin Mine*

*by Robert W. Gloyn*

In 1992 with the closure of the Trixie mine, there were no mines operating in the Tintic district of western Utah and eastern Juab Counties for the first time in 123 years. Hopefully this situation will change in the near future with the possible reopening of the Burgin silver-lead-zinc mine in the eastern part of the district. A joint-venture partnership between Chief Consolidated Mining Company (50%), Akiko Gold Resources, Ltd. (25%), and Korea Zinc Company (25%) is exploring the Burgin mine, last mined in 1978. The recent exploration was started in 1994 by Chief Consolidated on behalf of the joint venture, but since July 1996 exploration has been done by Tintic Utah Metals LLC, the operator for the joint venture.

Most silver-lead-zinc deposits in this area are deep, geologically very complex, and usually not exposed at the surface so underground exploration is the most efficient way to discover additional ore. Typically, stations are established in and along existing underground workings or new tunnels are driven to reach selected locations for additional stations. Special underground diamond drills are then used to drill directional holes from these stations. Commonly several holes are drilled from the same station, often in a fan pattern to explore more area. The recent exploration of the Burgin deposit has followed this pattern: the joint venture has repaired and rehabilitated the Apex shaft to provide access to the 1,050-foot level, driven approximately 3,000 feet of new drifts and cross cuts for underground drill stations, and drilled 41 holes with a total footage of over 18,000 feet. By the end of the first quarter of 1997 the joint venture will have spent nearly $6 million on exploration.

Of 41 holes drilled to date, over half encountered significant lead, zinc and silver, and seven contained minable gold values. One of the best drill holes was CB-20 which intersected 92 feet assaying 18.8 ounces/ton silver, 24 percent lead and 6.7 percent zinc. Nearly all of the exploration work has been directed toward extending the limits of the Main Burgin ore body downdip to the west and northwest. Drilling has confirmed the downdip and western extension of the ore body to the equivalent of the 1,600-foot level; 250 to 300 feet below the lowest existing workings. The most recent reserve calculations (April 1996) indicate 1.5 million tons of proven and probable ore at an average grade of 16.5 ounces silver/ton, 21 percent lead, and 6.7 percent zinc. Additional underground drilling is planned including work on the relatively untested southern and southwestern extensions of the Main Burgin ore body.

Thyssen Mining Construction of Canada, Ltd. has been retained to prepare an economic feasibility study scheduled to be completed by April 1997. If project financing is subsequently obtained, then mine planning, construction, and development could begin almost immediately with production scheduled to begin as early as mid-l999. Production is anticipated to be 315,000 tons per year over a minimum five-year mine life. Annual production would be 4.6 million ounces of silver, nearly 120 million pounds of lead, and 22 million pounds of zinc.

Cumulative production of the Burgin mine totaled 1,870,218 tons of ore containing 11.37 million ounces of silver, 353 million pounds of lead, 370 million pounds of zinc, and over 3 million pounds of cadmium. These amounts are a significant part of the cumulative production of the Tintic district which from 1869 through 1987 “produced somewhat more that 19.1 million tons of ore containing approximately 272 million ounces of silver, 1.14 million tons of lead, 225,000 tons of zinc, 127,000 tons of copper, and 2.77 million ounces of gold” (Morris, 1990), making it the third-largest metal-mining district in Utah behind Bingham Canyon and Park City. However, if the value of all commodities mined is considered, Tintic would probably be close to Park City because it also produced large amounts of other commodities including iron, manganese, bismuth, cadmium, and halloysite clay which was used for petroleum refinery catalysts. Using 1996 metal prices, the Tintic district has produced over 2 billion dollars worth of gold, silver, copper, lead, and zinc.

*Robert W. Gloyn joined the Utah Geological Survey in 1988. Prior to joining the Survey, he worked in the mineral industry for 21 years as an exploration and mine geologist in the United States, Latin America and Australia concentrating on uranium and base and precious metals deposits. He is currently a Senior Geologist with the Economic Geology Section specializing in metallic mineral deposits.*

**Reference:** Morris, H.T., 1990, Gold in the Tintic mining district *in* Gold-bearing polymetallic vein and replacement deposits - part II: U.S. Geological Survey Bulletin 1857-F, p. Fl-Fl l.

*Acknowledgments: Mr. Keith Droste of Tintic Utah Metals LLC provided much valuable information on the current exploration program and his assistance is gratefully acknowledged.*

# The Rockhounder

*by Dustin L. Rooks*

## *Smokey Quartz and Feldspar Crystals at Rock Corral Canyon in the Mineral Mountains, Beaver County*

**Geologic information:** The Mineral Mountains, located in Beaver County, make up the largest exposed plutonic body in Utah. Rock compositions range from quartz monzonite in the northern half of the pluton to granite around Rock Corral Canyon in the south. Excellent crystals of smoky quartz and feldspar are found in vugs or cavities in the granite. They formed when cooling fractures in the granite were filled by late-stage pegmatites consisting of quartz, microcline, and plagioclase. Quartz occurs as clear to smoky, euhedral crystals up to three inches long while microcline is commonly found as euhedral, equidimensional crystals averaging approximately 0.75 inches in width. Occasionally, large pseudomorphs of limonite after pyrite can be found in these areas as well.

**How to get there:** Travel 0.7 miles south of the railroad tracks on State Route 21 from Milford where a *Corral Recreation Area* sign will instruct you to turn left (east) from the highway. This road is paved for a short distance but then turns to sand. Continue from the turn-off 5.4 miles to an intersection. Take the left fork and continue for 1.2 miles to another intersection. Keep right at this intersection for 2.7 miles to the first outcrop or inselberg on the left. You can park here or continue to the picnic area in Rock Corral Canyon.

**Where to collect:** Although the quartz and feldspar are not confined to Rock Corral, the best-developed crystal specimens seem to occur within a half-mile radius of the picnic area. As mentioned above, the crystals are found in vugs. Look for areas where the quartz and feldspar are easily visible as coarse veins. Examine these areas closely as occasionally they open up into cavities where the crystals had space to grow.

**Useful maps:** Beaver and Wah Wah Mountains South 1:100,000-scale maps, and a Utah highway map. These are best for navigational purposes. Also, the Adamsville and Bearskin Mountain 1:24,000-scale maps. Topographic maps can be obtained from the Natural Resources Bookstore, 1594 W. North Temple, Salt Lake City, UT 84116, (801) 537-3320, FAX (801) 537-3395.

*Smoky quartz and microcline crystals from the Rock Corral area collected by the author in November of 1996. Note quarter in the foreground for scale.*

**Land ownership:** Bureau of Land Management (BLM) public lands.

**BLM collecting rules:** The casual collector may take small amounts of petrified wood, fossils, gemstones, and rocks from unrestricted federal lands in Utah without obtaining a special permit if collection is for personal, noncommercial purposes. Collection in large quantities or for commercial purposes requires a permit, lease, or license from the BLM.

**Miscellaneous:** A hat and water are essential. Tools recommended : Safety glasses, hammer, chisel, and patience are a must. Have fun collecting!

Visit our Rockhounder web page at http://www.ugs.state.ut.us/rockhndr.htm

*About the author:*

*Dustin L. Rooks is a Junior at Southern Utah University where he is majoring in both geology and botany. He is a native of Vernal, Utah where he spends summers conducting range studies for the National Forest Service and collecting rocks, minerals, and fossils.*

# Energy News

## Paradox Basin Minerals Symposium Heralded as a Great Success

Following nearly two years of planning, the Utah Geological Survey (UGS) along with the Utah Geological Association (UGA), U.S. Geological Survey, U.S. Bureau of Indian Affairs, Four Corners Geological Society, U.S. Department of Energy (DOE), and the Ute Mountain Ute Tribe sponsored a field trip and symposium on the "Geology and Resources of the Paradox Basin." The symposium, held in Durango, Colorado in mid-September 1996, brought together speakers from industry, government, and academia to present new findings and perspectives on the geology, petroleum resources, and infrastructure of the Paradox basin.

The symposium, the first to cover the basin since the early 1980s, was preceded by a three-day field trip to examine the stratigraphy, structure, and mineral resources of the basin. The trip began in Moab and proceeded southward and eastward across much of the basin. The first day of the trip covered the northern Paradox basin. Stops included the Moab fault, Salt Valley anticline, Moab mine tailings, Morrison and Cutler Formations, La Sal Mountains, Onion Creek diapir, La Sal copper mine, uranium mines, a limestone quarry, and the site of the first dinosaur discovery in Utah. The second day included a guided raft trip down the San Juan River to examine archaeological sites, excellent exposures of Pennsylvanian to Jurassic strata, and petroleum reservoir outcrop analogs. On the third day of the trip, participants journeyed from Bluff eastward across the Ute Mountain Ute Indian Reservation to Durango and discussed petroleum resources, recovery techniques, and infrastructure in the region. The highlight of the field trip was the raft trip on the San Juan River which began near Bluff and ended at the outskirts of Mexican Hat. While viewing archaeological sites and the grandeur of the area, our main objective was to closely examine carbonate algal-mound outcrops which are exposed in only a few places in the entire basin. These algal mounds are carbonate buildups which are very productive in the southern part of the Paradox basin but are difficult to locate due to their relatively small size. Much of the day was spent examining the lithology, stratigraphy, and structure of several mounds which were partially exposed along the river.

*San Juan River raft trip ends near Mexican Hat.*

In addition to leading the raft trip, several UGS personnel (project team members) conducted a workshop on the Paradox Basin Project which is part of the DOE Class II Oil Program. The program's overall objective is to increase oil production in older, producing fields through enhanced-oil recovery methods. The Paradox project involves the geologic investigation, reservoir characterization, and simulation modeling of five Greater Aneth satellite fields located in the southwestern part of the Paradox basin. An enhanced-oil recovery demonstration program will take place in one of the five fields following the completion of the modeling and simulation study. The workshop encompassed all aspects of the geology, reservoir characterization, and reservoir modeling that have been developed over the past two years.

Many of the presentations made at the symposium, as well as the road log for the field trip were published in a special UGA guidebook titled *Geology and Resources of the Paradox Basin*. The volume contains a large body of new data, analyses, and interpretations created in the past few years due, in part, to several government programs but also to renewed interest in the area by industry. Included in the guidebook are two Paradox Basin Project papers which present the results of the alga mound outcrop and reservoir-characterization work.

The symposium consisted of two days of technical presentations preceded by an evening of food and entertainment hosted by the Ute Mountain Ute Tribe. The program for the first day included a general session with presentations by representatives of the Ute Mountain Ute Tribe, Utah and Colorado State Geological Surveys, U.S. Bureau of Indian Affairs, U.S. Geological Survey, and the American Association of Petroleum Geologists followed by a program which included display booths, a poster session, and the DOE/UGS workshop. The program for the second day included sessions dealing with Economic Geology, Structure and Tectonics, Resource Development on Indian Lands, Petroleum Geology, Paleontology, and Stratigraphy and Sedimentology.

The symposium, hosting 135 attendees from as near as Durango and Farmington and as far away as Calgary and Houston, was a great success. The UGA guidebook, volume number 25, can be obtained through the Natural Resources Bookstore located at 1594 West North Temple, Salt Lake City, UT 84116. You can contact the bookstore by phone at 801-537-3320 or by email at nrugs.geostore@state.ut.us. Quarterly project reports and other data for the Paradox Basin Project can be found through the UGS home page at http://www.ugs.state.ut.us/paradox.htm.

# Coal Conference Addresses Coal Industry Concerns

A conference, 'The Future of Utah's Coal Industry', was held in response to the creation of the Grand Staircase-Escalante National Monument, which took many Utahns by surprise this past September and raised numerous concerns for Utah's coal industry. The conference was sponsored by the Utah Geological Survey and Division of Oil, Gas and Mining, two divisions within the Utah Department of Natural Resources (DNR). Over 130 coal industry personnel, resource managers, planners, legislators, and other interested people attended the conference which was held at the DNR building in Salt Lake City on December 5, 1996.

Designation of the new 1.7 million-acre Grand Staircase-Escalante National Monument will affect development of numerous federal oil and gas leases, and coal leases as well as the disposition of more than 176,000 acres of Utah School Trust lands. In addition to the impact on a substantial quantity of coal, other issues discussed were: (1) the market, environmental, and political constraints on coal mining in Utah; (2) the availability of other minable coal resources in Utah; (3) trading federal coal leases within the monument for other federal coal lands, and trading out Utah School Trust lands within the monument for lands of comparable value elsewhere in Utah; (4) priority bidding rights on future federal coal lease sales; (5) the effects of mining on federal versus state lands; (6) recent railroad mergers and the effect on coal transportation; and (7) the outlook for electric power generation through the 21st century.

Some of the more important conclusions drawn from the conference are listed below.

> The loss to development of the Kaiparowits Coal field's 22.7 billion tons of minable coal reserves significantly shortens the expected life of Utah's coal industry (the minable reserve for all of Utah, including Kaiparowits, is 44.7 billion tons). Utah's economically recoverable coal resources are now sufficient to support only 30 to 60 years of mining at current rates.
>
> The impact on Utah's rural communities through the loss of skilled, high-paying jobs, and the economic loss to the sate of a multi-billion-dollar industry will be far reaching.
>
> Utah coal competes in an international market, and cannot be thought of simply in terms of local or regional markets.
>
> Utah's coal miners are leaders in longwall mining innovation and productivity.
>
> The process of federal lands exchanges in Utah has been lengthy and not very successful to date.
>
> The impact of electric utility deregulation will place stiff competition on coal-fired power plants from highly efficient, combined-cycle gas turbines as utilities strive to find ways to deliver electricity at the lowest cost possible. Construction of large, coal-fired power plants is unlikely in the foreseeable future.
>
> Coal transport companies are finding cheaper and more innovative ways to transport coal from the mine to the consumer. In some instances the transporter helps manage the fuel inventory for the producer as well as for the consumer.

While the conference addressed many of the issues facing Utah's coal industry, it was obvious to all attendees that many questions remain unanswered. Details regarding the exchange of coal leases within the monument, reimbursement of lost mineral revenues to the state's public-education system, and the management of all resources within the monument are critical issues that need to be addressed and may be the subject of future coal conferences.

The Utah Geological Survey has recently released Circular 93, A Preliminary Assessment of Energy and Mineral Resources within the Grand Staircase-Escalante National Monument. It is available through the Natural Resources Bookstore located at 1594 West North Temple, Salt Lake City, UT 84116. You can contact the bookstore by phone at 801-537-3320 or by email at nrugs.geostore@state.ut.us.

# Oil Recovery Demonstration Program Begins with Acid Treatment in the Bluebell Field

**Background**

The Bluebell program, sponsored by the U.S. Department of Energy and managed by the Utah Geological Survey, was designed to demonstrate economical increases in petroleum production through the use of geologic analysis and modern oil field technology. The Bluebell field, located in Duchesne and Uintah Counties, Utah, along the northern margin of the Uinta Basin, has been the object of an intense geological and reservoir characterization study over the past three years. This study is now finished and work has begun on a three-part demonstration program which includes: (1) re-completing a well (Michelle Ute 7-1) that experienced formation damage during drilling operations, (2) redrilling part of a well (Malnar Pike 1-17) that experienced formation damage during the original drilling and completion, and (3) drilling and completing a new well. The first part of the Bluebell demonstration program, which includes acid treatment of the Michelle Ute 7-1 well, is designed to demonstrate that substantial producible oil exists in older wells if selective treatments to individual stratigraphic horizons are applied. The acid treatment of the Michelle Ute 7-1 well was conducted in late December 1996. No start-up dates have yet been established for the second and third parts of the demonstration program.

**Michelle Ute 7-1 Acid Treatment**

Based on a thorough analysis of post-completion well treatments of other Bluebell wells, a three-step program was planned for the Michelle Ute 7-1 well. The first step was to log the well prior to treatment in order to establish baseline geophysical data. The second step involved perforating several new horizons and extending several existing perforated intervals based on the integration of geological data from surrounding wells. The third step was to conduct a multi-stage acid treatment of the well, involving several hundred feet of perforated intervals in each stage. The selection of intervals was based on formation pressures encountered while drilling the well. Post-treatment logging was designed to identify successfully treated zones; if the well flowed naturally, the logging would identify and gauge the relative productivity of producing zones.

First, the well was shut down, production equipment and tubing were removed, and the well bore was cleaned out. The well was then logged in order to: (1) determine which beds contain open fractures, (2) identify which beds still contain hydrocarbons, and (3) delineate individual rock types for stratigraphic correlation. Comparison of pre- and post-treatment logs will be used to identify newly created fractures, productive intervals, and relative productivity of individual zones.

Following the logging, nearly 60 feet of perforations were made in 18 intervals at well depths ranging from 12,900 to 14,200 feet. Perforations were made using a series of explosive devices which blasted a metallic powder through the well casing creating approximately 1/2-inch-diameter holes. Some perforations opened up new horizons while others were located adjacent to existing perforated zones.

The acid treatment was designed to be conducted in three stages from the lowest depth interval to the highest. The treatment was to consist of three consecutive steps: (1) a pre-acid brine wash; (2) a high-pressure injection of an acid solution to increase oil flow through perforated zones; and (3) a post-acid injection of additives to prevent paraffin, iron, and mineral scale precipitation. Radioactive tracers were added to the acid injection to allow for detection of treated zones during post-treatment logging. The first two stages of treatment failed immediately after pressure build-up but before any acid was pumped. The failure was thought to be due to a failed cement bond outside the casing or a pressure-induced leak at the injection annulus. The third stage of treatment was then re-designed to include all three depth intervals. The treated interval was 1,540 feet in length beginning at 12,899 feet. Injection pressure was maintained between 4,500 and 6,000 pounds per square inch (psi) rather than the optimum 10,000 psi, due to a suspected leak in the injection tubing.

Following the treatment, work continued for several days to clean out remaining treatment fluids and to induce oil production. The well was put back into temporary production in early January 1997, and is currently producing at the rate of approximately 40 barrels of oil per day. Lower than normal injection pressure combined with the increased interval likely resulted in a less than adequate treatment of the lower part of the interval. Within the next few months a new down-hole pump will be installed to see if additional productivity can be achieved. Geophysical logs will be run at that time and a thorough analysis of the treatment will be completed.

A daily well activity summary can be found on the UGS home page at http://www.ugs.state.ut.us/bluebell.htm.

# “Glad You Asked”

*by Sandy Eldredge*

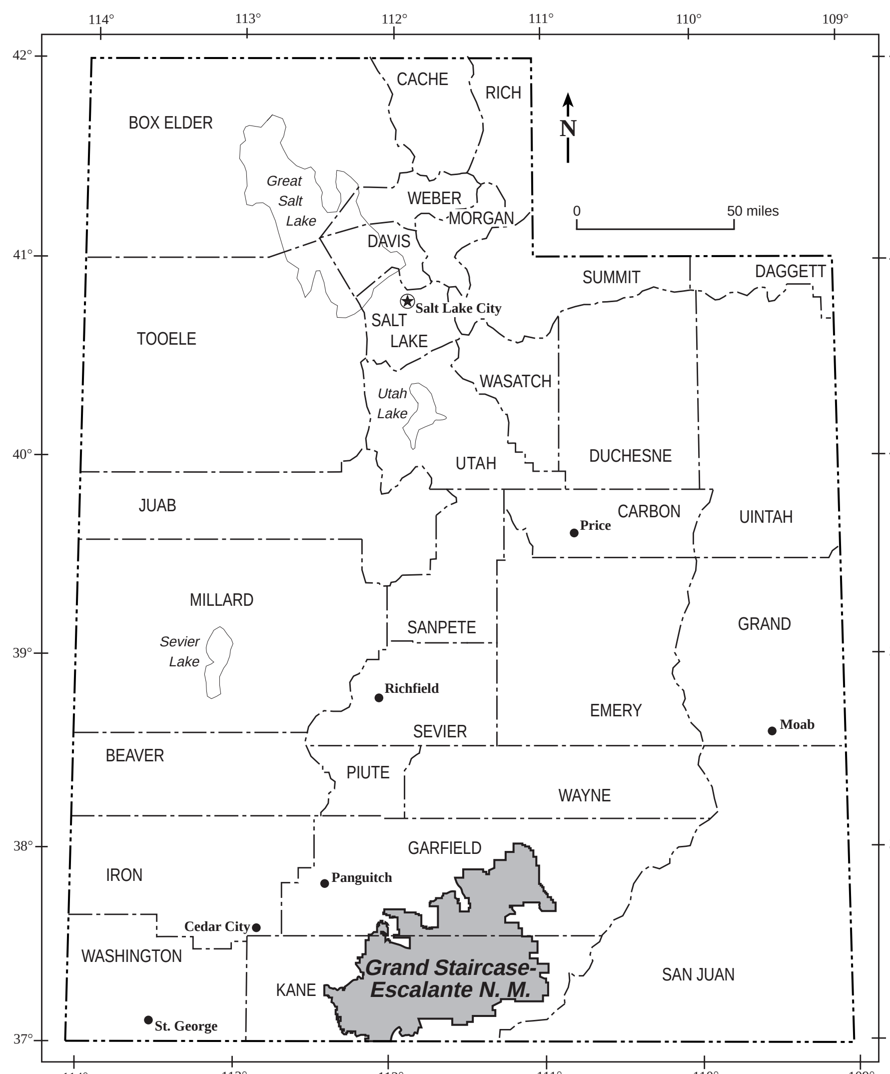
## *Can I collect rocks in the Grand Staircase - Escalante National Monument?*

No, except on the parcels of Utah Trust Lands, and then only with a permit.

As of September 18, 1996, when the nation’s newest national monument was established, almost 2,700 square miles in southern Utah were officially closed to rock, mineral, and fossil collecting. The Grand Staircase-Escalante National Monument sets aside this land to be protected for its scientific, historic, biologic, cultural, and scenic attributes. Although many land uses are still to be determined in this new monument, the U.S. Bureau of Land Management (BLM) is following in the footsteps of the National Park Service by disallowing collecting.

However, for now you can still collect on the Utah Trust Lands within the new monument.

What does this mean? Well, a little more work for you.... First, you should obtain the BLM map of the monument (available at BLM Utah State Office in Salt Lake City or at our Natural Resources Bookstore) which shows the monument boundaries and land status. Then, ascertain where you want to collect. Collecting is not allowed on any lands within the monument, except on the parcels of Trust Lands (Trust Lands are scattered, checkerboard fashion, throughout Utah and are typically one-square-mile sections). If you want to collect on Trust Lands, you need to obtain a permit.




*The Grand Staircase-Escalante National Monument encompasses a large portion of Kane County and part of Garfield County.*

To acquire a permit, contact the School and Institutional Trust Lands Administration’s offices in either Salt Lake City, St. George, Moab, or Richfield. A $10.00 fee is required for an individual or family. The fees go to Utah’s Uniform School Fund and other trust beneficiary institutions.

# New Publications of the UGS

A preliminary assessment of energy and mineral resources within the Grand Staircase-Escalante National Monument, compiled by M.L. Allison, 36 p., 1/97, C-93 ........ **$4.00**

Petrographic and physical characteristics of Utah coals, by B.P. Hucka, S.N. Sommer, and D.E. Tabet, 80 p., 1 disk, 1997, C-94 .................................. **$7.00**

A preliminary assessment of archeological resources within the Grand Staircase-Escalante National Monument, Utah by D.B. Madsen, 23 p., 3/97, C-95 .............. **$3.00**

A preliminary assessment of paleontological resources within the Grand Staircase-Escalante National Monument, Utah by D.D. Gillette and M.C. Hayden, 34 p., 1997, C-96 .... **$4.00**

Topographic map of the Grand Staircase-Escalante National Monument, Utah, 3/97, scale 1:200,000, PI-49 ..... **$4.00**

Technical reports for 1996, Applied Geology Program, compiled by B.H. Mayes, 183 p., 2/97 RI-231 ........ **$7.70**

Interim geologic map of the Moroni Peak quadrangle, Wayne County, Utah by S.R. Mattox, 41 p., 1 pl., 1:24,000, 2/97, OFR-343 ............................... **$4.75**

Lower Carboniferous echinoderms from northern Utah and western Wyoming, by G.D. Webster, 65 p., 1997 (Paleontology Series v. 1), B-128 ....................... **$6.50**

Geologic map of the Bear Lake South quadrangle, Rich County, Utah by J.C. Coogan, 16 p., 3 pl., 1:24,000, 1997, MP97-1 ..................................... **$9.25**

Geologic map of the Sheeppen Creek quadrangle, Rich County, Utah by J.C. Coogan, 17 p., 3 pl., 1:24,000, 1997, MP97-2 ..................................... **$9.25**

Interim geologic map of the Monument Peak quadrangle, Box Elder Co., Utah by D.M. Miller and Holly Langrock, 34 p., 1 pl., 1:24,000, 4/97 OFR-344 .............. **$4.75**

Interim geologic map of the Monument Peak NW quadrangle, Box Elder Co., Utah and Oneida Co., Idaho by D.M. Miller, 34 p., 1 pl., 1:24,000, 4/97 OFR-345 ......... **$4.75**

Interim geologic map of the Monument Peak NE quadrangle, Box Elder Co., Utah and Oneida Co., Idaho by D.M. Miller, 34 p., 1 pl., 1:24,000, 4/97 OFR-346 ........ **$4.75**

Interim geologic map of the Monument Peak SW quadrangle, Box Elder Co., Utah and Oneida Co., Idaho by D.M. Miller and Holly Langrock, 34 p., 1 pl., 1:24,000, 4/97 OFR-347 ................................... **$4.75**

Interim geologic map of the Monument Point quadrangle, Box Elder Co., Utah by D.M. Miller and Holly Langrock, 34 p., 1 pl., 1:24,000, 4/97 OFR 348 .............. **$4.75**

Interim geologic map of the Locomotive Springs quadrangle, Box Elder Co., Utah by D.M. Miller, 34 p., 1 pl., 1:24,000, 4/97 OFR-349 ....................... **$4.75**

Surficial geologic map of the Nephi segment of the Wasatch fault zone, eastern Juab County, Utah, by K.M. Harty, W.E. Mulvey, and M.N. Machette, 14 p., 1 pl., 1:50,000, 1997, M-170 ................................... **$4.85**

*We've reprinted two items of interest:*

Soils as a tool for applied Quaternary geology, by P.W. Birkeland, M.N. Machette, K.M. Haller, 63 p., 4/91,MP91-3 **$6.50**

Geothermal resources map of Utah, by UGS staff, 1 pl., approx. scale 1:1,000,000, 1990 PI-4 ................ **$2.00**

*And, of course, we have a new UGS publications list (February 1997) which is available just for the asking: contact the DNR Bookstore at (801) 537 3320, by fax at (801)537-3395, by internet at http://www.ugs.state.ut.us/bookstor.htm or, if real, live people still interest you, you can drop by for a visit at 1594 W. North Temple.*

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*Mail or Fax order to:*

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# New Utah Minerals

*by Robert L. Keefe*

All of the following minerals were discovered at the Centennial Eureka mine of the Tintic Mining District in Juab County.

**Frankhawthorneite,** $Cu_2Te^{6+}O_4(OH)_2$

Frankhawthorneite is a copper-tellurium hydrate found either isolated or in groups as elongate crystals on drusy quartz in vugs in the waste rock from the mine. Individual crystals are up to 0.1 mm long and are subhedral to euhedral. Frankhawthorneite is leaf green in color and has a green streak with a vitreous luster and is transparent. X-ray study reveals a monoclinic symmetry. Frankhawthorneite is nonfluorescent under ultraviolet light and is brittle with an uneven fracture. The mineral has a hardness of 3-4 and a density of 5.43 g/cm$^3$.

Frankhawthorneite is found in association with mcalpinite and several Cu- and Te-bearing secondary minerals. Frankhawthorneite is named for F.C. Hawthorne of the University of Manitoba.

**Jensenite**, $Cu_3Te^{6+}O_6 \cdot 2H_2O$

Jensenite is a copper-tellurium hydrate which occurs as single crystals up to 0.4 mm long or as groups of crystals on white to colorless quartz. The crystals are mainly simple rhombs, some slightly elongate. The color is transparent emerald green with a green streak and adamantine luster. X-ray study indicates monoclinic symmetry. Jensenite is nonfluorescent and brittle with a uneven fracture and a fair {101} cleavage. It has a hardness of 3-4 and a density of 4.78 g/cm$^3$.

Jensenite is found associated with mcalpinite, xocomecatlite, and several unnamed Cu- and Te-bearing minerals. Jensenite is named for M.C. Jensen who first recognized the mineral.

**Leisingite,**
$Cu(Mg,Cu,Fe,Zn)_2Te^{6+}O_6 \cdot 6H_2O$

Leisingite is another copper-tellurium hydrate discovered at the Centennial Eureka mine. The mineral was found as isolated hexagonal thin plates or as foliated masses in druses in quartz. Individual crystals average <0.1 mm across and are euhedral to subhedral. Leisingite's color ranges from pale yellow to pale orange-yellow. It has a pale yellow streak, a vitreous luster, and is transparent. X-ray structure study indicates a hexagonal symmetry. Leisingite is nonfluorescent under ultraviolet light and is brittle to slightly flexible with a perfect {001} cleavage. The mineral has a hardness of 3-4 and a density of 3.41 g/cm$^3$.

Leisingite is found in association with jensenite, cesbronite, and hematite in quartzose dump material. Leisingite was named for J.F. Leising, a geologist who helped collect the discovery specimens.

**References**

Grice, J.D., Groat, L.A., and Roberts, A.C., 1996, Jensenite, a cupric tellurate framework structure with two coordinations of copper: Canadian Mineralogist, v. 34, p. 55-59.

Grice, J.D., and Roberts, A.C., 1995, Frankhawthorneite, a unique HCP framework structure of cupric tellurate: Canadian Mineralogist, v. 33, p. 649-653.

Roberts, A.C., Grice, J.D., Criddle, A.J., Jensen, M.C., Harris, D.C., and Moffat, E.A., 1995, Frankhawthorneite, $Cu_2Te^{6+}O_4(OH)_2$, a new mineral species from the Centennial Eureka mine, Tintic district, Juab County, Utah: Canadian Mineralogist, v. 33, p. 641-647.

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Roberts, A.C., Groat, L.A., Grice, J.D., Gault, R.A., Jensen, M.C., Moffat, E.A.,and Stirling, J.A.R., 1996, Leisingite, $Cu(Mg,Cu,Fe,Zn)_2Te^{6+}O_6 \cdot 6H_2O$, a new mineral species from the Centennial Eureka mine, Tintic district, Juab County, Utah: Mineralogical Magazine, v. 60, p. 653-657.

# Survey News

The Grand Staircase-Escalante National Monument continues to have an impact on UGS's staff and products. The staff produced three new circulars (see New Publications) assessing mineral, archaeological, and paleontological values of the region. And veteran geologist **Bob Blackett** was selected to work with the Bureau of Land Management team that will develop the comprehensive management plan for the monument over the next three years. The appointment means Bob will be moving to Cedar City. Hope he likes Shakespeare!

We welcomed new employees including **Tim Madden**, **Brenda Nguyen**, **Jeff Quick**, **Mark Milligan**, and **Catharine Woodfield**. Tim is the public affairs officer at UGS. He has experience in journalism, public relations, and media relations. Brenda is the new secretary for the Applied Geology and Geologic Mapping programs, replacing **Ailan Lynch**. She comes to us from three years with the Division of Oil, Gas and Mining. Jeff, a project geologist in the Economic Geology program, has experience in organic petrology and was a research assistant professor at the University of Utah before joining the UGS staff. He earned a Ph.D. in geology at the University of Canterbury. Catharine's background includes work as a project geologist with the Indiana Geological Survey, where she was involved in terrain mapping and seismic-risk analysis. She earned a master's degree in geology at Indiana University. **Gabrielle Woodbury** is giving up the bones (she has been working in Paleo all winter) to pursue a Master's in English. **Mike Hylland** has accepted a position in Mapping and will leave the Applied group in May. **Mark Milligan** has joined the GES group. Mark's background is with an environmental firm in California followed by an MS at University of Utah.

UGS Director Lee Allison was the featured presenter at the Utah Geological Association monthly meeting in February. He discussed the politics of geology as it relates to the energy and mineral resources of the Grand Staircase-Escalante National Monument. His conclusion: Geologists and mining engineers will be on the front lines of a debate that is unlikely to be resolved any time soon. In other words, the flak will be flying for a while yet.

The UGS Home Page on the Internet is attracting more and more attention every day. Since December 1995, we logged more than 10,000 separate addresses; the daily average is about 125 individual visitors, and the Bulletin Board averages 10-15 downloads a day and about 30 hits a day.

The UGS recently re-organized to create the Environmental Sciences Program. The new service, under the management of **Mike Lowe**, maintains and publishes records of Utah's fossil resources, provides paleontological and archaeological recovery services to state and local governments, conducts studies of environmental change to aid resource management, and evaluates the quantity and quality of the state's groundwater resources.

**Tom Chidsey**, **Craig Morgan**, and **Doug Sprinkel** of the Economic Geology Program conducted poster sessions at the American Association of Petroleum Geologists international meeting in Dallas, Texas, April 5-9. Tom's topic was "Reservoir Modeling of the Anasazi Carbonate Mound, Paradox Basin, Utah"; Craig's was "Improving Oil Recovery from a Fluvial-dominated Deltaic Lacustrine Reservoir, Uinta Basin, Utah"; Doug's topic was "Emerging Plays in Central Utah Based on a Regional Geochemical, Structural, Stratigraphic Evaluation."

**Lee Allison**, **Dave Gillette**, and **Dave Madsen** were all interviewed and quoted extensively by newspaper and television reporters following the release of three new reports having to do with the Grand Staircase-Escalante National Monument. **Barry Solomon** dealt the dirt about increased chances this spring for slope failure and debris flows. **Tom Chidsey** spoke with The Associated Press and a writer for a professional journal about the latest developments in the Paradox Basin.

# GSA Field Trips

Salt Lake City is hosting the October 1997 GSA Annual Meeting, and planners have come up with a diverse and fascinating slate of field trips. Emphasizing the "Global Connections" theme, conference attendees can choose from a program that will be of interest to geoscientists from all disciplines and all parts of the world. Contacts are Bart Kowallis (Brigham Young University, bkowallis@byu.edu) or Paul Link (Idaho State University, linkpaul@isu.edu).

**Pre-meeting Trips**

1. Late Devonian Alamo Impact Event, Global Kellwasser Events, and Major Eustatic Events, Eastern Great Basin, Nevada and Utah
2. Stratigraphy and Structure of Sevier Thrust Belt and Proximal Foreland-Basin System in Central Utah: A Transect from the Sevier Desert to the Wasatch Plateau
3. Sequence Stratigraphy in a Classic Area: Evolution of Fluvial to Marine Architecture in Response to Tectonism and Eustasy, Cretaceous Foreland Basin, Utah
4. Regional Geology of Southeastern Utah, Emphasizing National Parks
5. Late Ordovician Mass Extinction and Glacio-eustasy -- Sedimentologic Biostratigraphic, and Chemostratigraphic Records from Shelf and Basin Successions, Central Nevada
6. Neoproterozoic Sedimentation and Tectonics in West-Central Utah
7. Bimodal Magmatism, Basaltic Volcanic Styles, and Tectonomagmatic Evolution of the Eastern Snake River Plain, Idaho
8. Late Pleistocene-Holocene Cataclysmic Eruptions at Nevado de Toluca and Jocotitlan volcanoes, Central Mexico
9. Neotectonics, Fault Segmentation, and Geological Hazards Along the Hurricane Fault in Utah and Arizona
10. The Grand Tour of the Ruby-East Humboldt Metamorphic Core Complex, Northeast Nevada
11. New Explorations Along the Northern Shores of Lake Bonneville
12. 50th Anniversary of the Discovery of the Ghost Ranch Coelophysis Quarry
13. Structure and Kinematics of a Complex Crater, Upheaval Dome, Canyonlands National Park, Utah

**One-day Pre-meeting Trips, October 18-19**

1. Geochemistry and Hydrology of the Great Salt Lake
2. Proterozoic Tidal, Glacial, and Fluvial Sedimentation in the Big Cottonwood Canyon, Utah
3. Examination of Fault-related Rocks of the Wasatch Normal Fault
4. Sequence Stratigraphy and Paleoecology of the Middle Cambrian Spence Shale in Northern Utah and Southern Idaho
5. Geologic Hazards of the Wasatch Front
6. Lake Bonneville Clastic Depositional Shore Features: Geochronology, Geomorphology, Stratigraphy, and Sedimentology

**Syn-meeting Field Trip**

Bedrock Geology of the Snyderville Basin

**Post-meeting Field Trips**

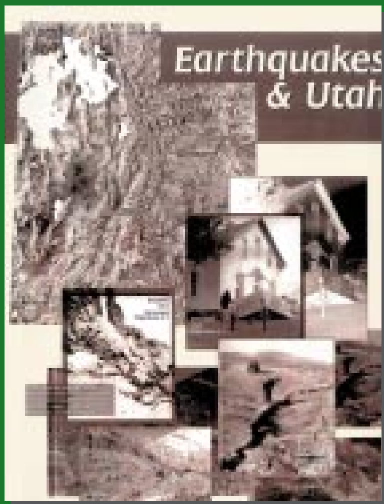
1. Fluvial-Deltaic Sedimentation and Stratigraphy of the Ferron Sandstone
2. Carbonate Sequences and Fossil Communities from the Upper Ordovician/Lower Silurian of the Eastern Great Basin
3. Mississippian Stratigraphy and Paleotectonics of the Antler Foreland, Eastern Nevada and Western Utah
4. Depositional Sequence Stratigraphy and Arcitecture of the Cretaceous (Turonian) Ferron Sandstone: Implications for Coal and Coal-Bed Methane Resources
5. Triassic and Jurassic Macroinvertebrate Faunas of Utah: Field Relationships and Paleobiologic Significances
6. Lower to Middle Cretaceous Dinosaur Faunas of the Central Colorado Plateau: A Key to Understanding 35 Million Years of Tectonics, Sedimentology, Evolution and Biogeography
7. Hinterland to Foreland Transect through the Sevier Orogen, Northeast Nevada to Southwest Wyoming: Structural Style, Metamorphism, and Kinematic History of a Large Contractional Orogenic Wedge
8. Extensional Faulting, Footwall Deformation and Plutonism in the Mineral Mountains, Southern Sevier Desert
9. Triassic- Jurassic Tectonism and Magmatism in the Mesozoic Continental Arc of Nevada: Classical Relations and New Developments
10. Bimodal Basalt/Rhyolite Magmatism in the Central and Western Snake River Plain, Idaho and Oregon
11. High, Old, Pluvial Lakes of Western Nevada
12. Quaternary Geology and Geomorphology, Northern Henry Mountains

**AWG Sponsored Post-meeting Trip**

Antelope Island, the Great Salt Lake, and Ancient Lake Bonneville

**SEG Sponsored Post-meeting Trip**

Geology and Ore Deposits of the Oquirrh and Wasatch Mountains, Utah with visits to the Bingham Mine




***Earthquakes and Utah*** **. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *available soon***

*Discover the answers to the commonly asked questions of where, why, and how often earthquakes occur in Utah; how big they are and how they are measured; and what may happen during an earthquake. The eight page pamphlet is filled with diagrams, maps, and photos and provides a good introduction to earthquakes in Utah.*

***Homebuyers guide to earthquake hazards in Utah*** **. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *$3.00***

*Earthquakes pose a risk to the majority of Utahns and it is important to be aware of the multi-hazard effects of an earthquake. This colorful 27 page brochure describes and illustrates in easy terms the hazards of ground shaking, liquefaction, fault rupture, slope failures, and flooding. It leads the reader to additional information sources on hazards in particular areas and about personal preparedness. A good introduction to help Utahns make informed choices when choosing where to live.*

***The Wasatch fault*** **. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *$2.00***

## *MONUMENTal publications*

*We produced several on the new National Monument. Ordering information can be found in New Publications on p. 12:*


***A preliminary assessment of energy and mineral resources within the Grand Staircase-Escalante National Monument*** **. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *$4.00***

*The summary information in this report gives a reasonable initial overview of commodities present in the monument. There are sections on oil and gas, coal and coal-bed methane, minerals, and tar sands. Emphasis is placed on determining possible valuation of School Trust land sections to begin the process of trading these for land outside the monument.*

***A preliminary assessment of archeological resources within the Grand Staircase-Escalante National Monument, Utah*** **. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *$3.00***

*The archeological resources of the area are so poorly known that it will be difficult to determine a viable management strategy, but surveys to date (extrapolated) indicate there may be about 11,000 sites (varying from lithic scatters, through campsites, to ruins) on the Utah State trust lands alone.*

***A preliminary assessment of paleontological resources within the Grand Staircase-Escalante National Monument, Utah*** ***$4.00***

*Paleontological studies have been conducted within the area of the monument and vicinity since the middle 1800s, so some idea of the richness of the fossil record can be stated. Several formations are worthy of considerably more research. An appendix lists all the confirmed taxa within the monument.*

**Utah Geological Survey**
1594 W. North Temple, Suite 3110
Box 146100
Salt Lake City, UT 84114-6100

Address correction requested
**Survey Notes**

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